XX. *On the magnetic Attraction of Oxides of Iron.* *By* Timothy Lane, *Esq. F. R. S.*

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HAVING found by experiment, that hardened iron is not so readily attracted by the magnet as soft iron, and that needles are inferior to iron wire as indexes to SIX's thermometer, I was proceeding to other comparative experiments, when I received the Second Part of last year's Philosophical Transactions, in which I saw an Analysis of magnetical Pyrites, with Remarks on Sulphurets of Iron, by Mr. HATCHETT.

This Paper led me to examine what magnetical properties iron possessed, when free from inflammable matter. For this purpose I obtained a precipitate of iron, prepared and sold at Apothecaries' Hall by the name of *Ferrum præcipitatum*. Mr. MOORE, the chemical operator, informed me, that he prepared it by dissolving twelve pounds of sulphate of iron in twenty-four gallons of distilled water, and then adding eight ounces of sulphuric acid to render the solution more complete. Twelve pounds of purified kali were mixed with the solution: the precipitate was well washed with hot distilled water, and then carefully dried. This precipitate is similar to the sediment of chalybeate waters, and affords no magnetic particles; nor, when exposed to a continued clear red heat, does it suffer any alteration beyond the acquirement of a darker colour. But if any smoke or flame has access to it, then magnetic particles

are evident. Heat, by the converging rays of the sun,* equal to that at which glass melts, blackens the oxide, but does not render it magnetic, if free from any inflammable matter. It is requisite, in this experiment, to protect the oxide, by glass, from the dust floating in the air, which otherwise will render many of the particles magnetic. I attributed this effect to the deoxidising property of light, till by employing a protecting glass, the result proved it to proceed from the dust in the atmosphere.

By repeated experiments I found, that heat alone produced no magnetic effect on the oxide, and that inflammable matter with heat always rendered some of the particles magnetic.

As the inflammable matter in coal had this effect, I mixed some of the oxide with a portion of coal in a glass mortar, and continued rubbing them together for some time without any magnetic effect. The mixture was then put into a tobacco-pipe, and placed in the clear red heat of a common fire; as soon as the pipe had acquired a red heat, it was taken out. The mixture was put on a glazed tile to cool, and proved highly magnetic.

I rubbed a portion of the original oxide in a glass mortar with a variety of substances, as sulphur, charcoal, camphor, ether, alcohol, &c. and found that no effect was produced without the assistance of heat. The heat of boiling water, moreover, was not sufficient; but by the heat of melting lead I procured magnetism. Small quantities of any inflammable matter in a red heat have an evident effect on the oxide. Hydrogen, aided by a red heat, renders the oxide magnetic.

* The lens employed in this experiment was twelve inches in diameter, and the heat at its focus was sufficient to melt iron; from Mr. DOLLOND.

Alcohol has the same effect. But if the alcohol be diluted with water, though it may flame in the fire, it will be ineffectual, as it is driven off before the oxide becomes sufficiently heated to receive its action.

Such combustible substances, as do not very readily part with their carbonic element, require rather longer continuance of heat than others: for example, charcoal and cinders, well burnt, must be longer in the fire to have their full effect on the oxide, than dry wood, coal, or sulphur.

But such substances as may be sublimed with facility, will gradually quit the oxide, by a continued application even of a low heat, leaving it unmagnetic, as at first.

How very small a portion of inflammable matter is requisite to render a considerable quantity of oxide magnetic, is evident, since one grain of camphor dissolved in an adequate portion of alcohol, and mixed with a hundred grains of the oxide in a glass mortar, will, by a red heat, render all the particles of the oxide magnetic.

As oxides of iron therefore are rendered magnetic by heat, when mixed with inflammable matter, it may be understood why Prussian blue, sulphurets, and ores of iron containing inflammable matter, become magnetic by the agency of fire; while at the same time it is observable, that these same ores revert to their unmagnetic state, when the heat has been continued sufficiently long to drive off the whole of the inflammable matter: thus we find among the cinders of a common fire calcined sulphurets of iron, distinguishable by their red colour, unmagnetic when all the sulphur is sublimed.

My intention in this communication is to prove generally that mere oxides of iron are not magnetic; that any inflam-

mable substances mixed with them do not render them magnetic, until they are by heat chemically combined with the oxides, and that when the combustible substance is again separated by heat, the oxides return to their unmagnetic state. That magnetic oxides cannot be distinguished from calcined oxides by their colour. I entertain a hope, however, that this subject may be found worthy of the accurate investigation of some other member of this learned Society.